Solution to the “Two-Talbot” problem of marine Pleistocene terraces in South Carolina

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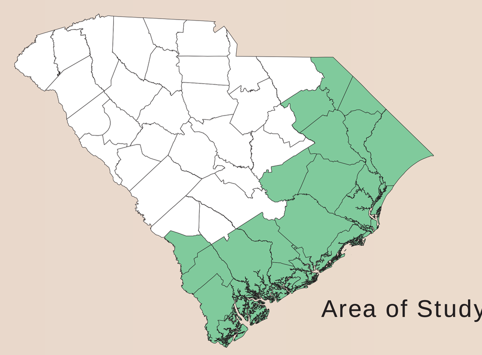
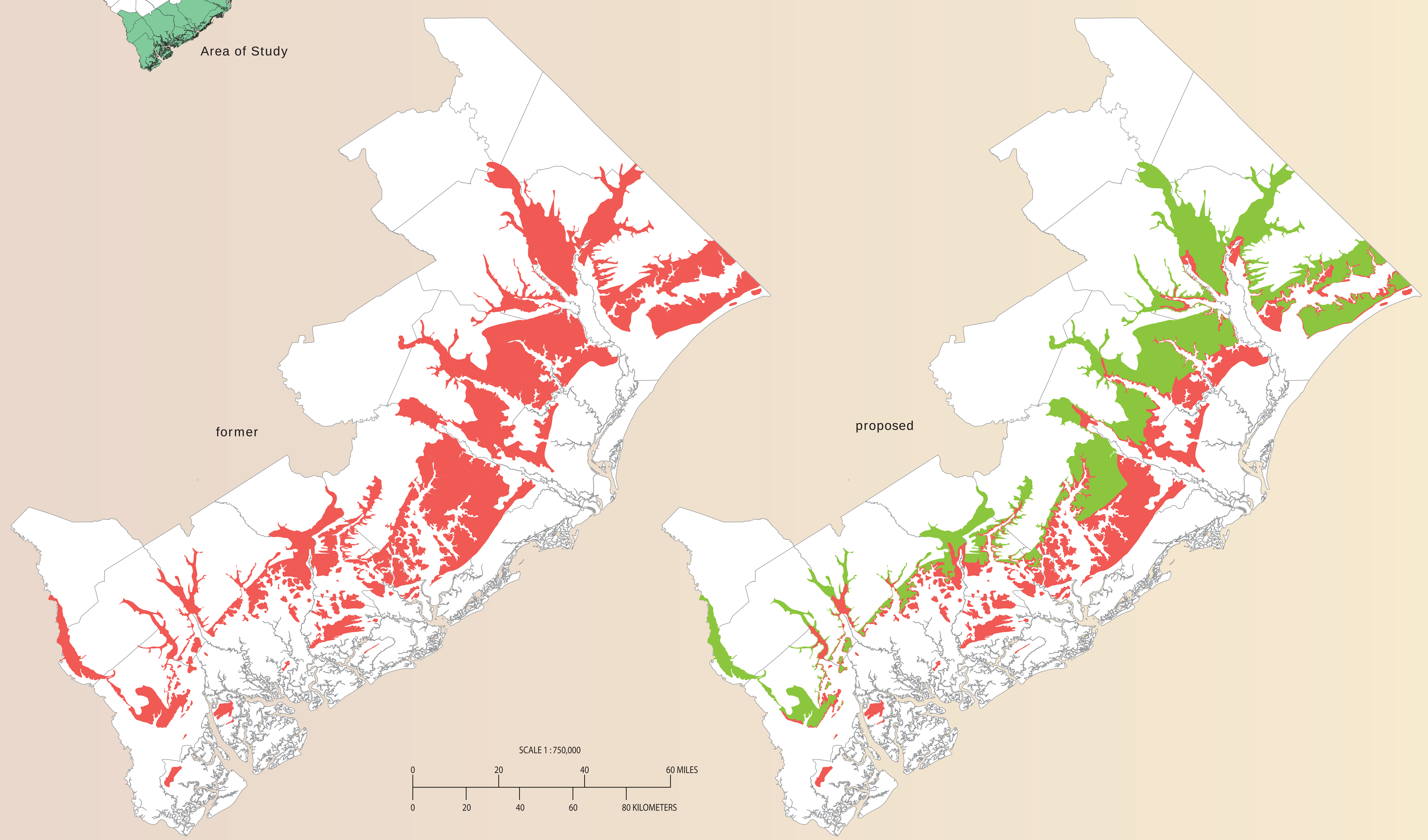
Shattuck (1901a, 1901b, 1906) named the Pleistocene Talbot terrace inland from the shore and seaward from a scarp at 35 ft in Talbot County, Maryland. Clark and others (1912) recognized the Chowan terrace, in North Carolina, seaward from a scarp with its toe at 60 ft and next inland from the Pamlico terrace at 20-25 ft. Later work (1) recognized the Talbot terrace southward into South Carolina, Georgia and Florida, (2) recognized three terraces seaward from the Talbot terrace (Colquhoun, 1969), and (3) established in South Carolina a “lower Talbot terrace” and an “upper Talbot terrace” (Colquhoun, 1972) that are underlain, respectively, by the Ten Mile Hill beds (200-250 ka) and Ladson Formation (400-450 ka; McCartan and others, 1990). The age of younger Pleistocene marine terraces reduces the effects of regional warping on them relative to Pliocene terraces. Removal of the Chowan terrace and younger terraces restricts the Talbot terrace as seaward from the scarp at 35 ft and landward from the scarp at 22-25 ft. The “upper Talbot terrace” has its toe at 57 ft in central South Carolina. Ideally, a terrace should represent one sea-level high stand, or maybe others, tied to one current maximum elevation. Following those logical restrictions, then, in South Carolina the “lower Talbot terrace”, which is underlain by the Ten Mile Hill beds, is the Talbot terrace and the “upper Talbot terrace”, which is underlain by the Ladson Formation, is here informally named the Cordesville terrace.

The informal Macbeth scarp is proposed for the marine scarp with its toe at 57 ft elevation in South Carolina. This toe is the seaward limit of the Penholoway terrace in South Carolina and is the landward limit of the informal Cordesville terrace in South Carolina [and perhaps of the Chowan terrace of North Carolina as well]. The toe of the Bethera Scarp (Colquhoun, 1965), at 35 ft elevation, is the seaward limit of the informal Cordesville terrace in South Carolina and is the landward limit of the Talbot terrace in South Carolina. The toe of the Suffolk Scarp (Johnson, 1907; Wentworth 1930) or the Cainhoy Scarp (Colquhoun, 1965), at 22-25 ft elevation, is the seaward limit of the Talbot terrace in South Carolina and is the landward limit of the Pamlico terrace in South Carolina. The terrace sediments in North Carolina that immediately underlie the Chowan terrace should correlate with the Ladson Formation in South Carolina.

Penholoway terrace
Penholoway Formation
MacBeth scarp
toe = 57 ft elev.
Cordesville terrace in South Carolina
Chowan terrace in North Carolina
Ladson Formation
Bethera Scarp
toe = 35 ft elev.
Talbot terrace
Ten Mile Hill beds
“upper Talbot terrace” of former usage
Suffolk Scarp =
Cainhoy Scarp
toe = 22-25 ft elev.
“lower Talbot terrace” of former usage
Pamlico terrace
“Pamlico beds”
Wando Formation, in part
<----“Talbot terrace” of former usage---->
Awendaw Scarp
toe = 15-17 ft elev.
Princess Anne terrace
“Princess Anne beds”
Wando Formation, in part
Mount Pleasant Scarp
toe = 10-12 ft elev.
Silver Bluff terrace
Silver Bluff beds
Wando Formation, in part
Atlantic Ocean shoreline = 0 ft elevation





THE FOUR ESSENTIAL ELEMENTS OF ATLANTIC COASTAL PLAIN MARINE TERRACE GEOMORPHOLOGY AND STRATIGRAPHY

Terrace
Scarp
Toe of scarp (or foot of scarp)
Formation

TERRACE

A marine terrace in the Atlantic Coastal Plain is a very gently inclined, southeast-sloping land surface developed on ancient, relatively nearshore, ocean-floor deposits that were later abandoned by a still later ocean highstand. Ocean-floor deposits become marine terraces (that is, on land) when the ocean level drops.

In South Carolina, land surfaces that now are marine terraces formed during the Pliocene and Pleistocene. Terraces are sequentially younger at lower elevations. Higher terraces are older, and lower terraces are younger. Multiple terraces in South Carolina (two Pliocene, seven Pleistocene) show that, since the mid-Pliocene, highstands of ocean level are trending toward lower levels, or southeastern North America is being uplifted, or some combination of both factors is at play.

A marine terrace that is overridden and buried by a later highstand of ocean level becomes a subsurface deposit and ceases to be a terrace. A few buried Pliocene or Pleistocene marine deposits occur in South Carolina. Marine terraces may be modified by fluvial, lacustrine, paludal, eolian, ground-water (karst), and marine processes (and perhaps others as well). Alluvium, colluvium, lakebed deposits, savannah deposits, swamp deposits, Carolina bay sediments (lakebed deposits and eolian rims), eolian dunes, eolian dune fields, eolian sheet sands, weathered soil profiles, and sinkhole deposits may be developed on marine terraces. Carolina bay sediments form by the combined actions of prevailing southwesterly winds under conditions of fluctuating ground-water levels. Carolina bays are common on the older terraces. In some cases a younger marine incursion has eroded the original seaward margin of an older terrace.

A sedimentary deposit currently accumulating major sediment is not a terrace. The sediment deposit becomes a terrace only after its sourcing or parental depositional system abandons the deposit and moves to a lower base level.

SCARP

A scarp is sloping land surface that forms the uphill and landward margin for one marine terrace deposit. In general, a scarp slopes more steeply than the younger deposits immediately seaward from its toe or foot. A scarp can have essentially the same gradient as the next-younger or next-lower terrace. A scarp was the passive landmass against or onto which the next-younger highstand of ocean level impinged. Ideally, terraces terminate landward and seaward, respectively, at the toes of the next-older and next-younger scarps. A younger marine incursion (highstand of ocean level) may erode the original seaward margin of an older terrace. In extreme cases, a younger marine excursion may erode a terrace from its seaward margin and beyond its landward margin, so that the entire older terrace is removed.

TOE OF SCARP

The toe (or foot) of a scarp is the inland limit to the marine or estuarine deposits of a particular highstand of ocean level. The toe of a scarp is the surface pinchout of the associated sea-level or oceanic highstand deposits. The toe occurs at the maximum highstand. The toes of scarps are major geomorphic boundaries between stratal units. With local exceptions such as eolian, swamp and fluvial deposits and erosion due to eolian, fluvial, marine and karst processes, the preserved land surfaces between geomorphic boundaries are unique to each underlying stratal unit.

FORMATION

Marine sediments deposited during a highstand of ocean level are abandoned during the next fall in ocean level. The deposits of the former marine system become a terrace deposit. The marine (later terrace) deposits may include beach deposits, barrier-island quartzose sands, offshore bar sands, sound deposits, nearshore shelf quartzose sands, offshore (but relatively nearshore) muds, local calcareous to shelly quartz sands and muds, and estuarine deposits. Together, these deposits:

- may have varied lithologies,
- have a consistent, inter-related internal geometry,
- have been parts of a single depositional system (depositional sequence), and thus
- represent a single episode of geologic history.

Marine terrace deposits are abutted by the deposits of a younger highstand of ocean level. Deposits of a particular marine or oceanic highstand extend in the subsurface some distance oceanward from the toe of the overlying scarp (oceanward from the next-younger highstand), but they do not extend oceanward indefinitely.

In general, the oceanward extent of each system of highstand deposits is eroded, removed, terminated, and reworked by a younger highstand of ocean level. Consequently, each set or marine terrace deposits preserves only the estuarine and relatively nearshore.

SOME COMPLICATING FACTORS

A later highstand of ocean level, or later land-based processes, may modify parts or all of a terrace. Regional warping can lead to a younger shoreline that intersects a former shoreline. A younger highstand (or highstands) may approximately co-occur with an older highstand. In this case, separating deposits of separate highstands will be a difficult task. Waves and wind of both normal and storm intensity deposit sand inland from active beaches. Beach storm deposits and eolian dunes contemporaneous with a given highstand occur inland from normal mean ocean level. On a terrace, beach storm deposits and eolian dunes that are near and inland from a toe-of-scarp may be coeval with marine deposits seaward of the toe-of-scarp.

Geomorphology can be a guide in understanding Atlantic Coastal Plain strata, but it not a foolproof route. Geological processes generate landforms. Understanding geologic processes, learning the distributions of lithologies, and understanding internal sedimentary frameworks are necessary in interpreting Atlantic Coastal Plain terrace strata.

REFERENCES

Clark, W. B., Miller, B. L., Stephenson, L. W., Johnson, B. L., and Parker, H. N., 1912, The Coastal Plain of North Carolina: North Carolina Geological and Economic Survey, Volume III, 552 pages.

Colquhoun, D. J., 1965, Terrace sediment complexes in central South Carolina: Atlantic Coastal Plain Geological Association Field Conference 1965. Columbia, University of South Carolina. 62 p.

Colquhoun, D. J., 1969, Geomorphology of the Lower Coastal Plain of South Carolina: Division of Geology, State Development Board, Columbia, South Carolina. MS-15, 36 p., 1 pl.

Johnson, B. L., 1907, Pleistocene terracing in North Carolina coastal plain. Science, new series,vol. 26, p. 640-642.

McCartan, L., Weems, R. E., and Lemon, E. M., Jr., 1990, Quaternary stratigraphy in the vicinity of Charleston, South Carolina, and its relationship to local seismicity and regional tectonism, p. i-iv, A1-A39, in Studies related to the Charleston, South Carolina, earthquake of 1886 Neogene and Quaternary lithostratigraphy and biostratigraphy: U. S. Geological Survey Professional Paper 1367.

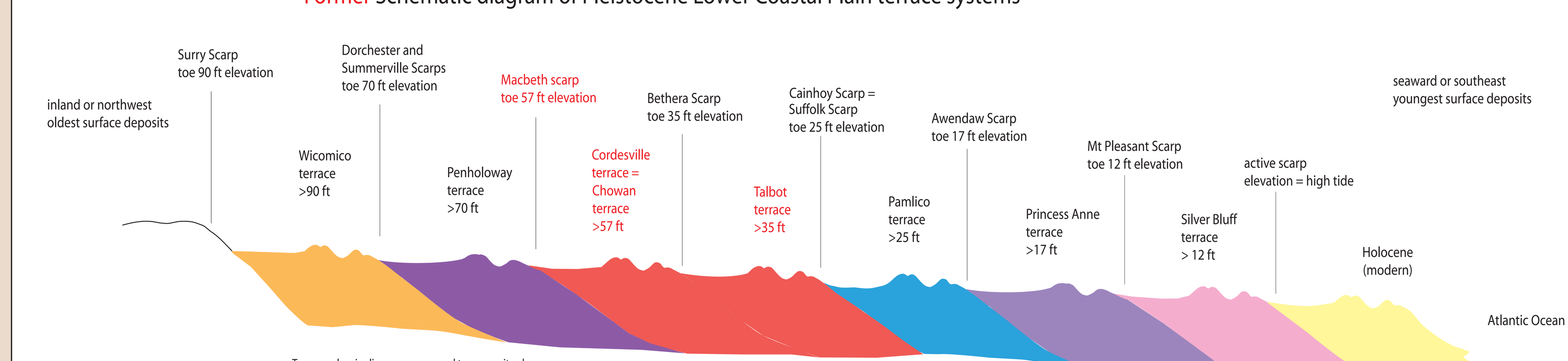
Shattuck, G. B., 1901a, The Pleistocene problem of the North Atlantic Coastal Plain: Johns Hopkins University Circular no. 152, May-June, 1901, p. 69-75.

Shattuck, G. B., 1901b, The Pleistocene problem of the North Atlantic Coastal Plain: American Geologist, v. 28, p. 87-107.

Shattuck, G. B., 1906, The Pliocene and Pleistocene deposits of Maryland. Maryland Geological Survey, Pliocene and Pleistocene, p. 21-137.

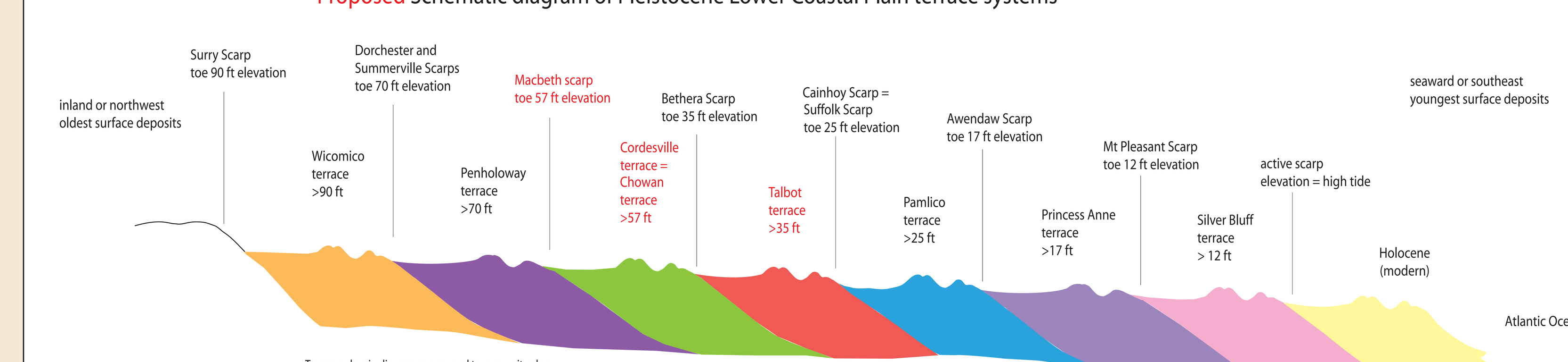
Wentworth, C. K., 1930, Sand and gravel resources of the Coastal Plain of Virginia: Virginia Geological Survey Bulletin 32, 146 pages, 19 plates, 154 figures, 4 tables.

Former Schematic diagram of Pleistocene Lower Coastal Plain terrace systems



Terrace colors in diagram correspond to map unit colors.

Proposed Schematic diagram of Pleistocene Lower Coastal Plain terrace systems



Terrace colors in diagram correspond to map unit colors.